REMARKS

In an Office Action dated 5 July 2005, the Examiner rejects claims 1-3 and 6-16. The Examiner also objects to the specification. Applicants respectfully amend claims 1-3; cancel claims 4, 8, and 16; and respectfully traverse the objection and rejections. Furthermore in light of the amendments and following arguments applicants respectfully request that claims 1-3, 5-7, 9-15 and 17 and this application be allowed.

Applicants have amended paragraphs 6 to include a reference that predates the priority date. Thus, Applicants respectfully request that this objection be removed.

Applicants also respectfully traverse the objection to paragraph 52 and 84 as having new material added. Specifically, the phase "substantially regularly spaced apart" for the word randomly to more correctly describe how islands of Germanium are formed in accordance with the Stranski-Krastanov growth method disclosed in the specification and shown in Figure 6. As can be seen from Figure 6, the lateral arrangement of Ge island formed by Stranski-Krastanov growth is not strictly periodical, but nevertheless, the islands have fairly sharp distance and size distributions. Hence, the islands are not randomly distributed but are substantially regularly spaced apart. Applicants respectfully submit the enclosed affidavit to support this assertion.

Specifically, Figure 6 shows the lateral arrangement of Ge islands formed by Stranski- Krastanov growth. The formed islands are **not** randomly distributed. Randomly distributed Ge islands would show a Gaussian distribution of regarding size, the distance and the orientation of the Ge islands. However, Figure 6 does not show a Gaussian distribution of the Ge islands.

Instead, the Ge islands shown in Figure 6 have a relatively sharp distribution as the side length of the Ge islands is in the range of 90 nm +/- 10 nm. The Ge islands shown in Figure 6 also have a relatively sharp distance distribution, as the distance between Ge islands is in a range of 150 nm +/- 10 nm. Furthermore, all of the Ge islands shown in Figure 6 have the same azimuthal orientation.

Since the shown Ge islands have a relatively sharp size and distance distributions as well as regular azimuthal orientation, the pattern shown is Figure 6 is not random. Instead, the pattern can be considered a substantially regular arrangement of Ge islands. Thus, Ge island formed by the Strnaski-Krastanov growth of Ge islands.

From the above amendment, it should be apparent that claims 5, and 17 are allowable under the species as having regularly spaced apart islands of Germanium. Thus, Applicants respectfully request that claims 5 and 17 remain pending in this application.

Applicants have canceled claim 8 and amended claims 2 and 3 to correct the antecedent problem with the highest doping density. Thus, Applicants respectfully request that the Examiner remove the objections to the claims.

The Examiner rejects claim 1 under 35 USC §103(a) as being unpatentable over Applied Physics Letter, No. 12 September 1999, pages 1745-1747 by Liu et al. (Liu) in view of U. S. Patent Number 4,679,061 issued to Capasso et al. (Capasso). In order to maintain a rejection the Examiner has the burden of providing evidence of prima facie obviousness. See MPEP §2143. See also In Re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). In order to prove prima facie obviousness, the Examiner must provide evidence in the prior art of a motivation to combine or modify a reference, a reasonable expectation of success, and a teaching of each and every claimed element. Id. The Examiner has failed to provide a teaching of each and every claimed element and has not provided evidence of a motivation to combine the references.

Claim 1 recites "a cladding layer of the opposite conductivity type to the base layer, the cladding layer being provided on the opposite side of said active zone from said base layer, wherein the Ge layers of the active zone each comprise a relatively thin layer of Germanium, each island having a relatively greater thickness than said thin layer, said islands forming quantum dots providing quantized energy levels for holes, and wherein the thickness of each silicon layer of said active zone is less than 5nm, so that holes are located in quantized energy levels associated with a valance band and electrons are localized in a miniband associated with the conduction band and resulting from the superlattice structure such that a direct transition between said miniband and said valence band is possible for charge carriers and light emissions are based upon interband transistions." Neither Liu nor Capasso teaches this limitation.

Specifically, Liu does not teach the thickness layer of each Silicon layer of the active zone is less than 5 nm. The small thickness of the Si layers in the active zone there is a correlation between adjacent layers results in the formation in the conduction band. As the electron scan moves freely in the miniband, a direct transition between the

miniband and the valence band is possible for charge carriers. This allows a recombination between holes captured in the quantum dots formed from the Ge islands and the electrons moving in the miniband. Thus, the structure recited in the invention of claim 1 provides light emission based upon interband transitions as recited in claim 1. As the width between the conduction band and the valence band is 1eV in the structure of amended claim 1, light of comparatively high energy and thus short wavelengths, specifically near the infrared region, is emitted.

As recited in claim 1 light emission of the claimed structures are based upon interband transitions, i.e. on transitions between the conductive band and the valence band. Thereby light of comparatively high energy having a short wavelength is emitted. Specifically, wavelengths in the near infrared region, e.g. in the range from 1.3 to 1.6 μm, can be achieved. The light emission further relies on the formation of a miniband for electron, i.e. on a miniband in the region of the electron conduction band as recited in the cladding layer recited of claim 1.

In contrast, Liu teaches a semiconductor structure having Si superlattice layers having a thickness of 6nm. This increase of thickness is enough to prevent the formation of a miniband of electrons in the Liu structure. Furthermore, Liu does not explicitly nor implicitly teaches a miniband. Instead, Liu teaches a structure that provides light emissions in the mid infrared range which corresponds to a large wavlenght of about 10 μm which is about ten times the wavelength that may be achieved by the structure recited in claim 1 thereby corresponding to an energy range in the range of 0.1 eV. Light emissions in an Si/Ge structure in this energy range cannot result in an interband transition i.e. for electron-hole recombination. Instead, the light emission in Liu is caused by intraband transitions, i.e. by transitions between energy levels within one band. For the sake of clarity, we enclose a drawing corresponding to Figs. 7 and 8 (Attachment A) of the present application, which illustrates the concepts of interband transitions and intraband transitions.

Specifically, in the case of Liu's structure the intraband transitions take place within the valence band, i.e. light is emitted when a hole transits from a state of higher energy to a lower state of energy within the valence band. As the transition is limited to the valence band, the energy of the emitted light is rather small as compared with the energy of emitted light from the structure recited in claim 1, i.e. the light emitted by the

Liu structure has a rather large wavelength of about 10 μm. Thus, the light emission of the Liu structure relies on intraband transitions, i.e. transitions within one band. Therefore, the Liu structure is based upon completely different physical principal from the structure recited in claim 1 that uses interband transitions. Therefore, the active region of Liu cannot "naturally function in a range of 1.3 μm to 1.6 μm.

The inventors have discovered that interband transitions can be achieved in a Si/Ge superlattice by forming a miniband for electrons by reducing the thickness of the Si layers in the Si/Ge superlattice to less that 5 nm. Surprisingly, the change from intraband transition to interband transition in the Si/Ge superlattice occurs in the Si layer thickness range between 5nm and 6nm. Liu neither mentions the concept of interband transitions nor teaches how to form such a transition. Specifically Liu neither suggests reducing the thickness Si layers nor teaches any implication for changing the thickness.

For all of the above reasons, Liu does not teach the cladding layer recited in amended claim 1.

Capasso also does not teach the cladding layer recited in claim 1. The semiconductor structure recited in Capasso is different from the structure of claim 1. In particular Capasso teaches the use of compound semiconductors. Further Capasso teaches the use of quantum well structures, i.e. layer structures. The Cladding layer and other layers recited in claim 1 are a heterostructure and is claimed specifically for Si and Ge which is not a compound semiconductor. Thus, Capasso does not teach the cladding layer recited in claim 1.

Since neither Liu nor Capasso teaches the cladding layer recited in claim 1, the combination of the references does not teach the cladding layer. Thus, the Examiner has failed to provide a teaching of the cladding layer. Therefore, Applicants respectfully request that the rejection of claim 1 be removed.

Furthermore, even if the combination teaches the cladding layer recited in claim 1, the Examiner has failed to provide a proper combination. See MPEP §2143.01. See also In re Ratti, 270 F2d 810, 123 USPQ 349 (C.C. P. A. 1959). Specifically, the combination cannot change the principle of operation of one of the references. This combination changes the principle of operations of Liu from light emission from intraband transitions to interband transitions. Furthermore, the combination does not create a structure as recited in claim 1 since the formation of a miniband of electrons, and the charge carrier

transition between the miniband and the valance band is not a property of the cladding layer but rather of the active zone of comprising the superlattice.

For these reasons, Applicants respectfully request that the rejection of claim 1 be removed and claim 1 be allowed.

Claims 2-3, 5-7, 9-15 and 17 are dependent upon claim 1. Thus, claims 2-3, 5-7, 9-15 and 17 are allowable for at least the same reasons as claim 1. Therefore, Applicants respectfully request that the rejections of claim 2-3, 5-7, 9-15 and 17 be removed and claims 2-3, 5-7, 9-15 and 17 be allowed.

If the Examiner has any questions regarding this response or the application in general, the Examiner is invited to telephone the undersigned at 775-586-9500.

Respectfully submitted,
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